Gray Quadrangle, Maine

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SURFICIAL GEOLOGY OF MAINE

Continental glaciers like the ice sheet now covering Antarctica probably extended across Maine several times during the Pleistocene Epoch, between about 1.5 million and 10,000 years ago. The slow-moving ice superficially changed the landscape as it scraped over mountains and valleys, eroding and transporting boulders and other rock debris for miles. The sediments that cover much of Maine are largely the product of glaciation. Glacial ice deposited some of these materials, while others washed into the sea or accumulated in meltwater streams and lakes as the ice receded. Earlier stream patterns were disrupted, creating hundreds of ponds and lakes across the state. The map at left shows the pattern of glacial sediments in the Gray quadrangle.

The most recent "Ice Age" in Maine began about 25,000 years ago, when an ice sheet spread southward over New England (Stone and Borns, 1986). During its peak, the ice was several thousand feet thick and covered the highest mountains in the state. The weight of this huge glacier actually caused the land surface to sink hundreds of feet. Rock debris frozen into the base of the glacier abraded the bedrock surface over which the ice flowed. The grooves and fine scratches (striations) resulting from this scraping process are often seen on freshly exposed bedrock, and they are important indicators of the direction of ice movement. Erosion and sediment deposition by the ice sheet combined to give a streamlined shape to many hills, with their long dimension parallel to the direction of ice flow. Some of these hills (drumlins) are composed of dense glacial sediment (till) plastered under great pressure beneath the ice.

A warming climate forced the ice sheet to start receding as early as 21,000 years ago, soon after it reached its southernmost position on Long Island (Sirkin, 1986). The edge of the glacier withdrew from the continental shelf east of Long Island and reached the present position of the Maine coast by 13,800 years ago (Dorion, 1993). Even though the weight of the ice was removed from the land surface, the Earth's crust did not immediately spring back to its normal level. As a result, the sea flooded much of southern Maine as the glacier retreated to the northwest. Ocean waters extended far up the Kennebec and Penobscot valleys, reaching present elevations of up to 420 feet in the central part of the state.

Great quantities of sediment washed out of the melting ice and into the sea, which was in contact with the receding glacier margin. Sand and gravel accumulated as deltas and submarine fans where streams discharged along the ice front, while the finer silt and clay dispersed across the ocean floor (**Localities 1-8**). The shells of clams, mussels, and other invertebrates are found in the glacial-marine clay that blankets lowland areas of southern Maine. Age dates on these fossils tell us that ocean waters covered parts of Maine until about 11,000 years ago, when the land surface rebounded as the weight of the ice sheet was removed.

Meltwater streams deposited sand and gravel in tunnels within the ice. These deposits remained as ridges (eskers) when the surrounding ice disappeared. Maine's esker systems can be traced for up to 100 miles, and are among the longest in the country.

Other sand and gravel deposits formed as mounds (kames) and terraces adjacent to melting ice, or as outwash in valleys in front of the glacier. Many of these water-laid deposits are well layered, in contrast to the chaotic mixture of boulders and sediment of all sizes (till) that was released from dirty ice without subsequent reworking. Ridges consisting of till or washed sediments (moraines) were constructed along the ice margin in places where the glacier was still actively flowing and conveying rock debris to its terminus. Moraine ridges are abundant in the zone of former marine submergence, where they are useful indicators of the pattern of ice retreat.

The last remnants of glacial ice probably were gone from Maine by 10,000 years ago. As the glacier left the region, the land emerged from the sea as a result of glacial unloading, a response of the earth's crust to the weight of the ice. Nearshore reworked deposits are the result of the land surface passing through the shore zone. Large sand dunes accumulated in late-glacial time as winds picked up outwash sand and blew it onto the east sides of river valleys, such as the Androscoggin and Saco valleys. The modern stream network became established soon after deglaciation, and organic deposits began to form in peat bogs, marshes, and swamps. Tundra vegetation bordering the ice sheet was replaced by changing forest communities as the climate warmed (Davis and Jacobson, 1985). Geologic processes are by no means dormant today, however, since rivers and wave action modify the land, and worldwide sea level is gradually rising against Maine's coast.

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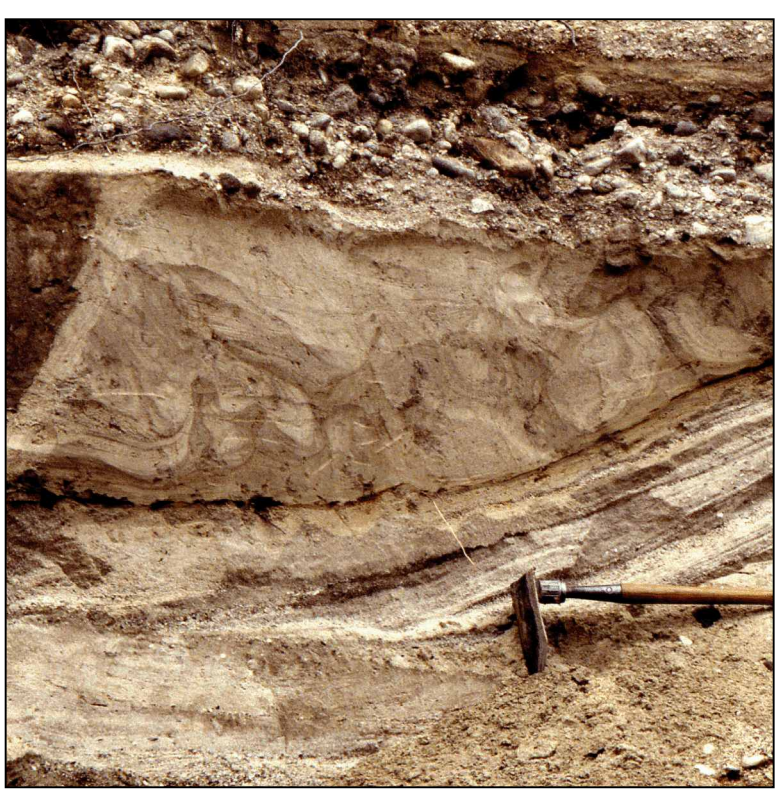
Locality 1. Overview of large gravel pit in East Gray delta (view to southeast). This ice-contact delta is the site of the largest kettle reported in Maine (Leavitt and Perkins, 1935). The topographic expression of the kettle is still visible on the quadrangle (marked by the letter k on the geologic map), however much of it has been obliterated by mining.

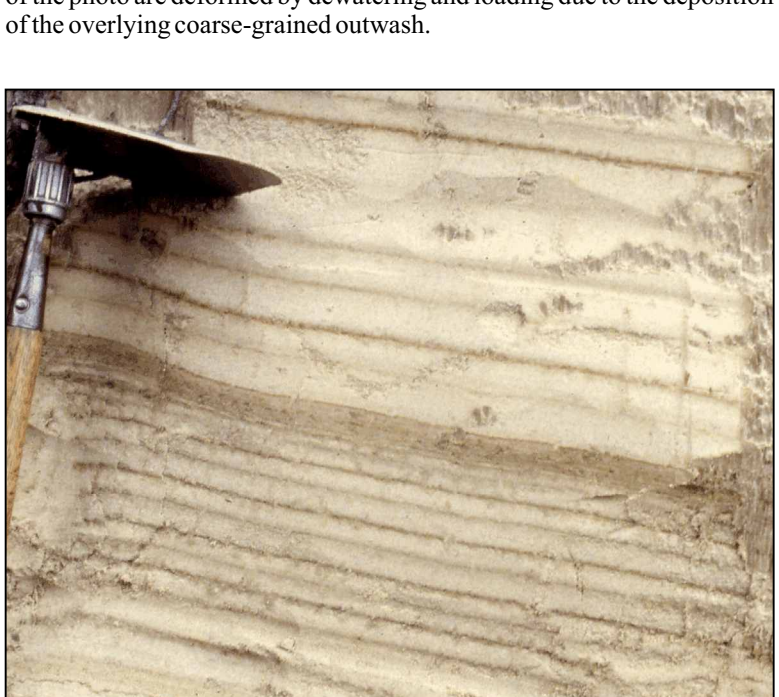
Locality 2. At the East Gray delta, cleanup of the McKin Superfund site is underway (note large auger in floor of excavation). Air stripping of contaminated ground water has occurred since the mid-1980's, however the contamination plume is still present and discharges from springs along the delta front to the east. The topset/foreset contact of the delta is visible near the top of the exposure. *(photo by Rebecca Hewett).*

Locality 3. Alluvial fan deposits overlying deltaic deposits. Coarse-grained sediment from a glacial source in the highland between Gray and east Gray prograded as a glacial alluvial fan (unit Pgf on the geologic map) over the deltaic sediments of the East Gray delta (unit Pmdeg on the geologic map). Strongly incised meltwater channels in the topography are present on the surface of the fan and delta.

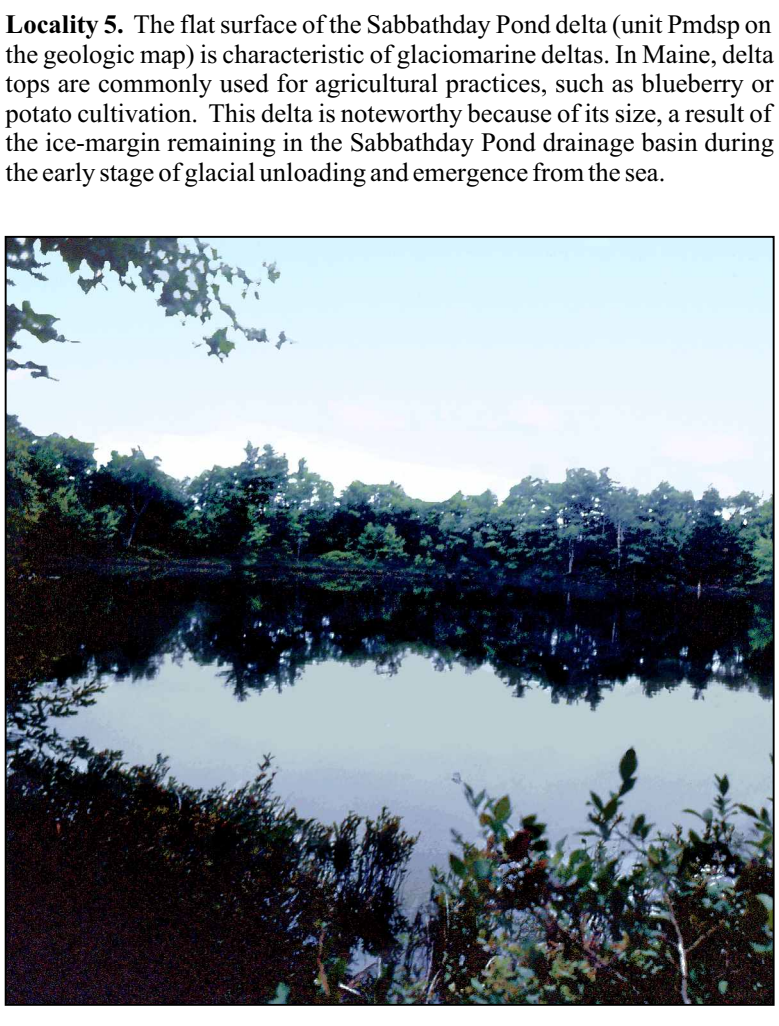


Locality 4. The Gray Meadow delta (unit Pmdgm on the geologic map) probably formed slightly earlier than the East Gray delta. Later, meltwater from the alluvial fan of Figure 3 reworked sediment on the surface of the Gray Meadow delta. Locally ponded deposits in the center of the photo are deformed by dewatering and loading due to the deposition of the overlying coarse-grained outwash.

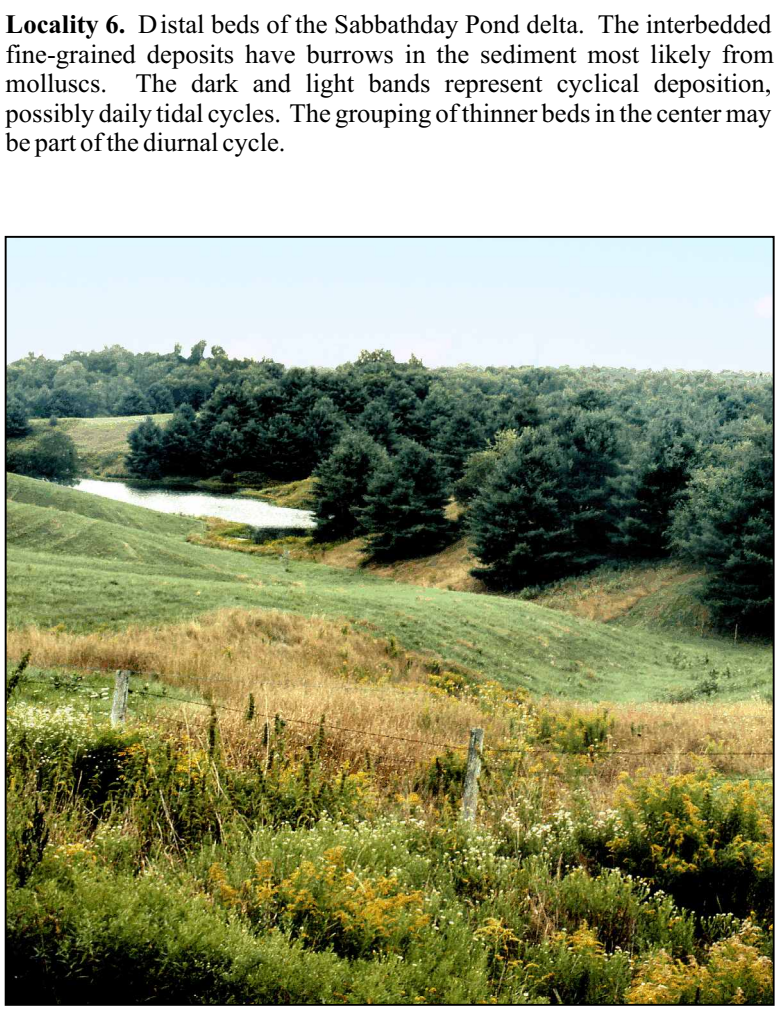
Locality 5. The flat surface of the Sabbathday Pond delta (unit Pmdsp on the geologic map) is characteristic of glaciomarine deltas. In Maine, delta tops are commonly used for agricultural practices, such as blueberry or potato cultivation. This delta is noteworthy because of its size, a result of the ice-margin remaining in the Sabbathday Pond drainage basin during the early stage of glacial unloading and emergence from the sea.



Locality 6. Distal beds of the Sabbathday Pond delta. The interbedded fine-grained deposits have burrows in the sediment most likely from molluscs. The dark and light bands represent cyclical deposition, possibly daily tidal cycles. The grouping of thinner beds in the center may be part of the diurnal cycle.



Locality 7. During deglaciation, a remnant block of glacial ice was buried by stream deposits beneath the surface of the Sabbathday Pond delta. The block eventually melted, producing a depression called a kettle, now filled with water and named The Sinkhole. Davis and Jacobson (1985) dated a sediment core from this pond and reported a radiocarbon age of 12,710+/-125 yr B.P., a minimum age for the delta.



Locality 8. Typical topography associated with the glaciomarine mud called the Presumpscot Formation (unit Pp on the geologic map). This fine-grained glacial sediment was deposited in the sea during deglaciation. The mud commonly erodes in hummocky, steep-gullied surfaces, well represented by the topography of the Royal River valley in the southeastern part of the quadrangle.